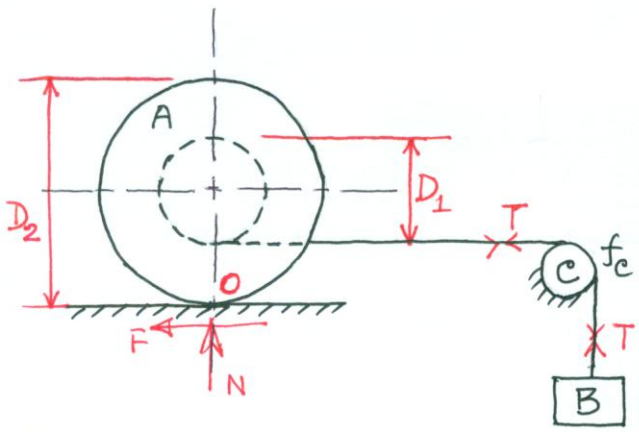
1450/P. 422



$W_A = 200$ lb
$\bar{I}_A = 6$ slug-ft^2
$D_1 = 2$ ft
$D_2 = 3$ ft
$W_B = 32.2$ lb
$f_c = 0$ (i.e. smooth peg)

(a) $\bar{v}_A = ?$ $a_B = ?$ for $s_B = 20$ ft
(b) $T = ?$
(c) How does $\bar{a}_A$ vary with increase of D_1?

Sol^n For the entire system,

$U_{net} = W_B \cdot s_B = 32.2 \times 20 = 644$ lb-ft

$\Delta KE = \frac{1}{2}\frac{W_B}{g} v_B^2 + \frac{1}{2}\cdot\frac{W_A}{g}\cdot\bar{v}_A^2 + \frac{1}{2}\bar{I}_A\omega_A^2$ —— (1)

[Considering c.g. of A as the ref. point]

Note: As B moves downward, A rolls to the left. Because of plane rolling, frictional force F does no work.

Now $\frac{\bar{v}_A}{v_B} = \frac{r_A\omega}{r_B\omega} = \frac{r_A}{r_B} = \frac{1.5}{0.5} = 3$

$\therefore \bar{v}_A = 3v_B$ or $v_B = \frac{\bar{v}_A}{3}$

$\omega = \frac{\bar{v}_A}{r_A} = \frac{\bar{v}_A}{1.5}$

$\omega \rightarrow$ angular velocity of c.g. of A.
$\bar{v}_A \rightarrow$ velocity of the c.g. of A
$v_B \rightarrow$ velocity of a point on the chord

Note: v_A and v_B are the velocities relative to point O, therefore ω is also the angular velocity of the c.g. of A about the instantaneous center O.

Therefore, from eq^n (1)

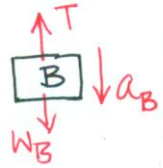
$\Delta KE = \frac{1}{2}\times\frac{32.2}{32.2}\times\frac{\bar{v}_A^2}{9} + \frac{1}{2}\times\frac{200}{32.2}\times\bar{v}_A^2 + \frac{1}{2}\times 6\times\frac{\bar{v}_A^2}{1.5^2}$

$= 4.494\,\bar{v}_A^2$

According to the principles of work and kinetic energy

$U_{net} = \Delta KE \Rightarrow 644 = 4.494\,\bar{v}_A^2 \quad \therefore \bar{v}_A = \boxed{11.97 \text{ fps}}$

$\therefore v_B = \frac{\bar{v}_A}{3} = \frac{11.97}{3} = 3.99$ fps.



For body B

$v_B^2 = 2a_B\cdot s_B \quad \therefore a_B = \frac{v_B^2}{2s_B} = \frac{3.99^2}{2\times 20} = \boxed{0.398 \text{ fps}^2}$

$\Sigma F_y = m_B a_B \downarrow +ve$

$\Rightarrow W_B - T = \frac{W_B}{g}\cdot a_B$

$\therefore T = W_B - \frac{W_B}{g}\cdot a_B = 32.2 - \frac{32.2}{32.2}\times 0.398 = \boxed{31.8 \text{ lb}}$